## NOx Control Cost Effectiveness Estimate

NOX CONTROL COST EMECTIVENESS ESTIMATE	<u> </u>			
Engine Manufacturer Model No.	Cooper-Rolls Coberra 125			
Engine Type	Cobella 125			
Fuel Used	Natural Gas			Color Legend
Emissions Control	SCR			User Data / Information Input Cell
Combustion Control Purpose Target Reduction	NOx 75%			"Cumulative" Cost Cell for Primary Categories Cost Effectiveness (\$ / ton)
Engine Design Conditions				Comments
Power Output	14300	(hp)		Rated HP
Engine Exhaust Temperature		(F)		optional input
Engine Exhaust Rate		(lb/hr)		optional input
Gas Volume		(dscfm)		optional input
rull Load Engine Exhaust Composition:				Comments
Oxygen (O <sub>2)</sub> Carbon Dioxide (CO <sub>2)</sub>		(vol. %)		optional input
Water (H <sub>2</sub> O)		(vol. %) (vol. %)		optional input optional input
Oxides of Nitrogen (NOx)		(ppmvd)		optional input
Nitrogen (N <sub>2)</sub>		(vol. %)		optional input
NOx	21	1.9 lb/hr	0.161 (lb/MMBtu)	NOx emissions from test data: 164.7 lb/MMSCF ~0.170 lb/MMI
				Q.,
Engine Parameters  Total Operating Hours per Season	8760	(hrs)	100% utilization	Comments
		(/		Comments
Final Exhaust Gas Composition Oxides of Nitrogen (NOx)		5.5 lb/hr	0.040 (lb/MMBtu)	Comments Assume 75% reduction
Economic Parameters		10/11	0.0 TO (ID/MINIDIA)	
Source of Cost Data	see Analysis			Comments  Analysis primarily relying on EPA Cost Manual
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Direct Costs  Combustion Control Equipment and Auxiliary		Cost Formula	1	Comments
Equipment	\$2,765,000	(A)		Based on EPA control cost manual (\$167/kw; adjust to 2020\$
Instrumentation	\$276,500	(0.1*A)		Calculated Cost using EPA Control Cost Manual
Sales Taxes Freight	\$91,245 \$138,250	(0.03*(A+instrun (0.05*A)	nentation))	3% Sales Tax in this example Calculated Cost using EPA Control Cost Manual
Purchased Equipment Cost (PEC)	\$3,270,995	PEC		Calculated Cost using EPA Control Cost Manual
Direct Installation Costs	<b>40,210,000</b>	Cost Formula		Comments
Foundations and Supports	\$261,680	(0.08*PEC)	1	Comments  Calculated Cost using EPA Control Cost Manual
Handling and Erection	\$457,940	(0.14*PEC)		Calculated Cost using EPA Control Cost Manual
Electrical	\$130,840	(0.04*PEC)		Calculated Cost using EPA Control Cost Manual
Piping Insulation for ductwork	\$65,420 \$32,710	(0.02*PEC) (0.01*PEC)		Calculated Cost using EPA Control Cost Manual Calculated Cost using EPA Control Cost Manual
Painting	\$32,710	(0.01*PEC)		Calculated Cost using EPA Control Cost Manual
Site Preparation	\$0 *0	SP		As required
Buildings  Total Installation Cost (TIC)	\$0 <b>\$981,300</b>	Bldg		As required
Total Direct Costs (PEC+TIC)	\$4,252,295		ı	
Indirect Costs	<b>V</b> 1,202,200	Cost Formula	!	Comments
Engineering	\$327,100	(0.10*PEC)	1	Calculated Cost using EPA Control Cost Manual
Construction and field expenses	\$163,550	(0.05*PEC)		Calculated Cost using EPA Control Cost Manual
Contractor fees Start-up	\$327,100 \$65,420	(0.10*PEC) (0.02*PEC)		Calculated Cost using EPA Control Cost Manual Calculated Cost using EPA Control Cost Manual
Performance test	\$32,710	(0.02 PEC)		Calculated Cost using EPA Control Cost Manual
Contingencies	\$98,130	(0.03*PEC)		Calculated Cost using EPA Control Cost Manual
Total Indirect Costs (IC)	\$1,014,008	(0.31*PEC)		
Capital Cost Summary				Comments
Total Direct Capital Costs (DC)	\$4,252,295			
Total Indirect Capital Costs (IC)  Total Capital Investment (TCI)	\$1,014,008 \$5,266,303			
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Operator Labor	\$12,500	nominal cost	1	Comments  0.5 hr/shift; example from similar EPA analysis
Supervisor Labor	\$12,500 \$1,875	noninai cost		0.5 nr/sniit; example from similar EPA analysis 15% of operator
Operating Materials - ammonia	\$22,530			materials estimate annual NH3 at \$700 per ton; 1.1 molar rat
Maintenance - Labor Maintenance - Materials	\$12,500 \$5,000	nominal cost		0.5 hr/shift; rate example from EPA
Maintenance - Materials Catalyst maintenance / replacement	\$5,000 \$138,250	nominal cost		Engineering Estimate Engineering Estimate (5% of Cap Cost)
Testing and QA/QC	\$20,000			Engineering estimate - Annual test; reagent controller QA
Electricity  Total Direct Annual Costs	\$2,500 <b>\$215,155</b>			Estimate based on analysis in PA DEP TSD
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ndirect Annual Costs	610.105	Cost Formula		Comments
Overhead Administrative Charges	\$19,125 \$105,326	(0.6*(OL+SL+MI (0.02*TCI)	_+iviivI))	Engine ACT Document
Property Taxes	\$52,663	(0.01*TCI)		Engine ACT Document
Insurance Capital Recovery	\$52,663 \$422,358	(0.01*TCI) CRF[TCI]	CRF 0.0802	Factor for costs annualized over 20 years at 5% interest.
Total Indirect Annual Costs	\$422,338 \$652,135	ON [101]		RF = i * (1+i)^n / [(1+i)^n - 1] (i expressed as a decimal - e.g., 10%
			5.	
Summary  Total Direct Annual Operating Costs	\$215,155		1	Comments
Total Indirect Annual Operating Costs  Total Indirect Annual Operating Costs	\$652,135			
Total Annual Costs	\$867,289		\$61 \$ per hp	
ncremental Annual Costs Over Baseline	\$867,289			
Annual Emissions Reduction Over Baseline				Comments
Oxides of Nitrogen (NOx)	71.	.85 (Tons)		
Cost Effectiveness (\$/Ton)				Comments
Oxides of Nitrogen (NOx)	\$12,0	71		
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NOX CONTROL COST EMEGRACIONS ESTIMATE				
Engine Manufacturer Model No.	Cooper-Rolls Coberra 125			
Engine Type	Coperra 125			
Fuel Used	Natural Gas			Color Legend
Emissions Control	SCR			User Data / Information Input Cell
Combustion Control Purpose Target Reduction	NOx 75%			"Cumulative" Cost Cell for Primary Categories Cost Effectiveness (\$ / ton)
	1070			Soci Ensourchood (\$\psi\ ton)
Engine Design Conditions	44000	10		Comments
Power Output Engine Exhaust Temperature	14300	(hp) (F)		Rated HP optional input
Engine Exhaust Rate		(lb/hr)		optional input
Gas Volume		(dscfm)		optional input
Full Load Engine Exhaust Composition:				Comments
Oxygen (O <sub>2)</sub>		(vol. %)		optional input
Carbon Dioxide (CO <sub>2)</sub>		(vol. %)		optional input
Water (H₂O)		(vol. %)		optional input
Oxides of Nitrogen (NOx)		(ppmvd)		optional input
Nitrogen (N <sub>2)</sub>		(vol. %)		optional input
NOx	23	3.1 lb/hr	0.170 (lb/MMBtu)	NOx emissions from test data: 172.9 lb/MMSCF ~0.170 lb/MMI
Engine Parameters				Comments
Total Operating Hours per Season	8760	(hrs)	100% utilization	Comments
	0.00	()		
Final Exhaust Gas Composition		5 O 11-/1	0.042 (IL/MMD4.)	Comments
Oxides of Nitrogen (NOx)	5	5.8 lb/hr	0.043 (lb/MMBtu)	Assume 75% reduction
Economic Parameters				Comments
Source of Cost Data	see Analysis			Analysis primarily relying on EPA Cost Manual
Direct Costs		Cost Formula		Comments
Combustion Control Equipment and Auxiliary	\$2,765,000	/.x		Based on EPA control cost manual (\$167/kw; adjust to 2020)
Equipment	\$276,500	(A) (0.1*A)		
Instrumentation Sales Taxes	\$276,500 \$91,245	(0.1"A) (0.03*(A+instrun	nentation))	Calculated Cost using EPA Control Cost Manual 3% Sales Tax in this example
Freight	\$138,250	(0.05*A)		Calculated Cost using EPA Control Cost Manual
Purchased Equipment Cost (PEC)	\$3,270,995	PEC		
Direct Installation Costs		Cost Formula		Comments
Foundations and Supports	\$261,680	(0.08*PEC)		Calculated Cost using EPA Control Cost Manual
Handling and Erection	\$457,940	(0.14*PEC)		Calculated Cost using EPA Control Cost Manual
Electrical Piping	\$130,840 \$65,420	(0.04*PEC) (0.02*PEC)		Calculated Cost using EPA Control Cost Manual Calculated Cost using EPA Control Cost Manual
Insulation for ductwork	\$32,710	(0.02 PEC) (0.01*PEC)		Calculated Cost using EPA Control Cost Manual
Painting	\$32,710	(0.01*PEC)		Calculated Cost using EPA Control Cost Manual
Site Preparation	\$0	SP		As required
Buildings  Total Installation Cost (TIC)	\$0 <b>\$981,300</b>	Bldg		As required
				1
Total Direct Costs (PEC+TIC)	\$4,252,295			
Indirect Costs		Cost Formula		Comments
Engineering Construction and field expenses	\$327,100 \$163,550	(0.10*PEC) (0.05*PEC)		Calculated Cost using EPA Control Cost Manual Calculated Cost using EPA Control Cost Manual
Contractor fees	\$327,100	(0.10*PEC)		Calculated Cost using EPA Control Cost Manual
Start-up	\$65,420	(0.02*PEC)		Calculated Cost using EPA Control Cost Manual
Performance test Contingencies	\$32,710 \$98,130	(0.01*PEC) (0.03*PEC)		Calculated Cost using EPA Control Cost Manual Calculated Cost using EPA Control Cost Manual
Total Indirect Costs (IC)	\$98,130 \$1,014,008	(0.03*PEC)		Calculated Cost using EPA Control Cost Manual
Total mandet edite (1.5)	<b>41,011,000</b>	(0.01 1 20)		
Capital Cost Summary				Comments
Total Direct Capital Costs (DC) Total Indirect Capital Costs (IC)	\$4,252,295 \$1,014,008	·		
Total Capital Investment (TCI)	\$5,266,303			1
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Direct Annual Costs		Cost Formula		Comments
Operator Labor Supervisor Labor	\$12,500 \$1,875	nominal cost		0.5 hr/shift; example from similar EPA analysis 15% of operator
Operating Materials - ammonia	\$1,875			materials estimate annual NH3 at \$700 per ton; 1.1 molar rat
Maintenance - Labor	\$12,500	nominal cost		0.5 hr/shift; rate example from EPA
Maintenance - Materials	\$5,000	nominal cost		Engineering Estimate
Catalyst maintenance / replacement Testing and QA/QC	\$138,250 \$20,000			Engineering Estimate (5% of Cap Cost) Engineering estimate - Annual test; reagent controller QA
Electricity	\$20,000 \$2,500			Estimate based on analysis in PA DEP TSD
Total Direct Annual Costs	\$216,414			•
Indirect Annual Costs		Cost Formula	Capital Recovery Factor	Comments
Overhead	\$19,125	(0.6*(OL+SL+MI		Comments
Administrative Charges	\$105,326	(0.02*TCI)	,	Engine ACT Document
Property Taxes	\$52,663	(0.01*TCI)	005	Engine ACT Document
Insurance Capital Recovery	\$52,663 \$422,358	(0.01*TCI) CRF[TCI]	CRF 0.0802	Factor for costs annualized over 20 years at 5% interest.
Total Indirect Annual Costs	\$652,135	J [. J.]		RF = i * (1+i)^n / [(1+i)^n - 1] (i expressed as a decimal - e.g., 10%
			-	
Summary	0040.444		<del></del> ,	Comments
Total Direct Annual Operating Costs Total Indirect Annual Operating Costs	\$216,414 \$652,135			
Total Annual Costs Total Annual Costs	\$868,549		\$61 \$ per hp	
Incremental Annual Costs Over Baseline	\$868,549		. ,	
Annual Emissions Reduction Over Baseline				Comments
Oxides of Nitrogen (NOx)	75	87 (Tons)		Comments
				<u> </u>
Cost Effectiveness (\$/Ton)				Comments
Oxides of Nitrogen (NOx)	\$11,4	49		